A Comparison of Methods for the Detection of Smooth Surface Caries

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Introduction

• Detection of non-cavitated caries is important because lesion progression may be halted at this stage, remineralized or minimally restored, thereby preserving natural tooth structure.

• Visual and tactile methods of caries detection only examine the tooth surface and not the lesion developing beneath it.

• Smooth surface changes may be detected visually but are there other methods to detect & monitor lesion changes over time?
Objective

This *in vitro* study evaluated the ability of The Canary System, DIAGNOdent, Spectra Caries Detection Aid, ICDAS II, and Radiographic Examination to detect smooth surface caries.
Materials and Methods

• 92 healthy & carious sites on smooth surfaces of extracted human teeth were used.

• A blinded, experienced operator scanned the teeth using The Canary System, DIAGNOdent and Spectra with three repeat measurements per site.

• Two blinded clinicians independently scored the teeth using ICDAS II.

• The same two blinded clinicians independently ranked radiographs of the teeth as ‘1’ for presence of caries and ‘2’ for absence of caries. **Note radiographs were taken with smooth surfaces mounted as interproximal lesions**

• Where there was disagreement between the clinicians’ scores, the site were re-examined by both clinicians together and a consensus score reached.
Canary Scale

1. Plastic Tip touches enamel surface
2. Laser diameter at the contact point = 50 microns
3. Thermal waves (PTR signals) radiate 1.5 mm across and up to 5 mm deep
4. PTR Amp and PTR-Phase signals are measured by infrared detector
5. Luminescence (LUM) Signals (glow) are detected

Canary Number is generated
Examining Lesions with Canary

- Angulation of Canary Tip will provide a range of Canary Numbers depending upon what is beneath the beam.
- As one scans along the occlusal surface one can detect & image the lesion.
- The Canary acts like a “punch biopsy” for examining the tooth surface.
Scanning the Occlusal Surface to Map the Lesion
Scanning the Occlusal Surface to Map the Lesion
Scanning the Occlusal Surface to Map the Lesion
Scanning the Occlusal Surface to Map the Lesion
DIAGNOdent Scale

0 - 10  Healthy Tooth Structure
11 - 20  Outer Half Enamel Caries
21 - 30  Inner Half Enamel Caries
30+  Dentin Caries

Source: DIAGNOdent Operating Guide
# Spectra Scale

<table>
<thead>
<tr>
<th>Displayed Color</th>
<th>Green → Blue → Red → Orange → Yellow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Displayed Number</td>
<td>1.0  →   &gt;3.0</td>
</tr>
<tr>
<td>Examine for</td>
<td>Healthy Tooth Use Gold Standard techniques to examine for potential caries.</td>
</tr>
</tbody>
</table>

Source: Spectra Operators Manual
Materials and Methods - Validation

- Polarized Light Microscopy (PLM) was performed blinded at the Department of Comprehensive Dentistry, University of Texas Health Science Center at San Antonio as validation.
Statistical Analysis - Correlation

• Correlation between ICDAS II scores and the numerical readings from The Canary System, DIAGNOdent and Spectra and the scores from Radiographic Examination were determined by Pearson’s coefficient of correlation (R2, p < 0.01).

• Correlation between lesion depth and the numerical readings from The Canary System, DIAGNOdent, Spectra and ICDAS II scores were determined by Pearson’s coefficient of correlation (R2, p < 0.01).
Sensitivity and specificity were determined using PLM results and the following criteria:

<table>
<thead>
<tr>
<th>Device</th>
<th>Sound</th>
<th>Caries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canary Number</td>
<td>≤ 20</td>
<td>&gt; 20</td>
</tr>
<tr>
<td>DIAGNODent</td>
<td>≤ 10</td>
<td>&gt; 10</td>
</tr>
<tr>
<td>SPECTRA</td>
<td>≤ 1</td>
<td>&gt; 1</td>
</tr>
<tr>
<td>ICDAS II</td>
<td>= 0</td>
<td>≥1</td>
</tr>
</tbody>
</table>
RESULTS
### Correlation with ICDAS II

<table>
<thead>
<tr>
<th>Caries Detection Method</th>
<th>Correlation with ICDAS II Scores (R²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Canary System</td>
<td>0.798</td>
</tr>
<tr>
<td>DIAGNOdent</td>
<td>0.244</td>
</tr>
<tr>
<td>Spectra</td>
<td>0.592</td>
</tr>
<tr>
<td>Radiographic Examination</td>
<td>0.091</td>
</tr>
</tbody>
</table>
Correlation with Lesion Depth (PLM)

<table>
<thead>
<tr>
<th>Caries Detection Method</th>
<th>Correlation with Lesion Depths ($R^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Canary System</td>
<td>0.583</td>
</tr>
<tr>
<td>DIAGNOdent</td>
<td>0.550</td>
</tr>
<tr>
<td>Spectra</td>
<td>0.423</td>
</tr>
<tr>
<td>ICDAS II</td>
<td>0.470</td>
</tr>
</tbody>
</table>
Representative Sample (#5A)

Representative sample with visually-carious examination site A and healthy examination site B.

- **Site A**
  - ICDAS $\geq 1$
  - Canary Number = 43
  - DIAGNOdent = 57
  - Spectra Value = 0

  - True Positive
  - True Positive
  - True Positive
  - False Negative

- **Site A**
  - PLM = 874 um
  - Gold Standard
Radiographic Exam Sample 5A

Buccal

Lingual
Sample 10B

<table>
<thead>
<tr>
<th>Device</th>
<th>Reading</th>
<th>Reading Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canary</td>
<td>66</td>
<td>True Positive</td>
</tr>
<tr>
<td>DIAGNODent</td>
<td>1</td>
<td>False Negative</td>
</tr>
<tr>
<td>ICDAS II</td>
<td>2</td>
<td>True Positive</td>
</tr>
<tr>
<td>SPECTRA</td>
<td>0.9</td>
<td>False Negative</td>
</tr>
<tr>
<td>PLM Depth</td>
<td>550.91 microns</td>
<td></td>
</tr>
<tr>
<td>Caries Detection Method</td>
<td>Sensitivity</td>
<td>Specificity</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-------------</td>
<td>-------------</td>
</tr>
<tr>
<td>The Canary System</td>
<td>0.84</td>
<td>0.91</td>
</tr>
<tr>
<td>DIAGNOdent</td>
<td>0.49</td>
<td>1.00</td>
</tr>
<tr>
<td>Spectra</td>
<td>0.51</td>
<td>1.00</td>
</tr>
<tr>
<td>ICDAS II</td>
<td>0.83</td>
<td>1.00</td>
</tr>
</tbody>
</table>
Conclusions: Detecting Smooth Surface Caries

• Strong positive correlation between Canary Numbers & ICDAS II scores for detecting smooth surface caries.

• Spectra, DIAGNOdent & Radiographic Examination demonstrated poorer correlation with ICDAS II.

• ICDAS II may not be as sensitive to changes in lesion size within each classification.

• The strong correlation between The Canary System and ICDAS II implies that these two methods may be combined to increase their effectiveness for detection of caries on smooth surfaces.

• ICDAS II & The Canary System showed superior sensitivity compared to DIAGNOdent and Spectra.
Thank You

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